

## THE WEATHER AND CIRCULATION OF FEBRUARY 1967

### Cold in the East But Continued Warm in the West

JULIAN W. POSEY

Extended Forecast Division, Weather Bureau, ESSA, Washington, D.C.

#### 1. MEAN CIRCULATION

The middle-latitude zonal index for the western portion of the Northern Hemisphere continued the general rise that began in November. This was true both at sea level and at the 700-mb. level. There were sharp two-to-three-week fluctuations in these indices, but in the averages for monthly periods (every 15 days) the trend was upward at all times from November through February (fig. 1). Mean monthly speeds of the 700-mb. westerlies (12.7 m.p.s.) and sea level westerlies (4.5 m.p.s.) between 35° N. and 55° N. in the Western Hemisphere were stronger this February than during any previous February since records have been available. Sea level index records began in 1943, and 700-mb. index records began in 1946.

Although the zonal index increased, the amplitude of the mid-tropospheric flow over North America and the adjacent oceans (fig. 2) did not remain small as it was during January [1]. The rising index resulted from increasing cyclonic activity and deepening Lows at the higher latitudes with concomitant building of the subtropical high pressure belt. Average 700-mb. heights for the month were above normal from the western Mediterranean Sea across the Atlantic to near the Bahamas then from the western Gulf of Mexico to the Asiatic coast (fig. 3). At the same time, two intense negative height anomalies developed with centers over Baffin Island and the Bering Sea.

The strong westerlies forced a progression of the long waves, with the blocking ridge that was observed over Greenland and Iceland during January [1] weakening and moving eastward to northern Europe. The southern portion of this ridge that was over Spain and northwestern Africa in January advanced a lesser distance to the central Mediterranean area. Even though most features progressed, the strong cyclonic vortex that had been over the Arctic basin moved very little, but it did deepen slightly to 570 ft. below normal. Another factor associated with the increased index was the loss of the Gulf of Alaska trough.

The anomalous flow across most of Asia was extremely weak (fig. 3). Here the similarity of the observed wind speed pattern to the normal wind pattern (fig. 4) also illustrates the normalcy of the flow over Asia this month. In the eastern Pacific a single major wind speed maximum

was observed north of its normal position, but in the western Pacific a very complex wind pattern was observed. The mean low pressure center over the Philippines (fig. 2) has been observed in that general location on all monthly mean charts since last fall. A daily stream function analysis for the Tropics did not show frequent cyclonic activity in the latter two-thirds of the month, but the presence of tropical storm Ruby in the Philippine area during the first nine days of February apparently was sufficient to produce a mean low pressure area for the month. However, there is some doubt that this feature was actually as intense as illustrated in figure 2. Since this feature is close to the boundary of the grid used in the automatic data processing system, and also in a sparse data area, further checks are being made to eliminate the chance of a spurious mean pressure system in this area.

#### 2. MONTHLY TEMPERATURES

Amplification of the mean upper-level flow during February over North America ended the extremely mild weather of January over the eastern half of the Nation (fig. 5). Strong building of the west coast ridge and the accompanying deepening of the east coast trough greatly increased the northerly flow over the United States.

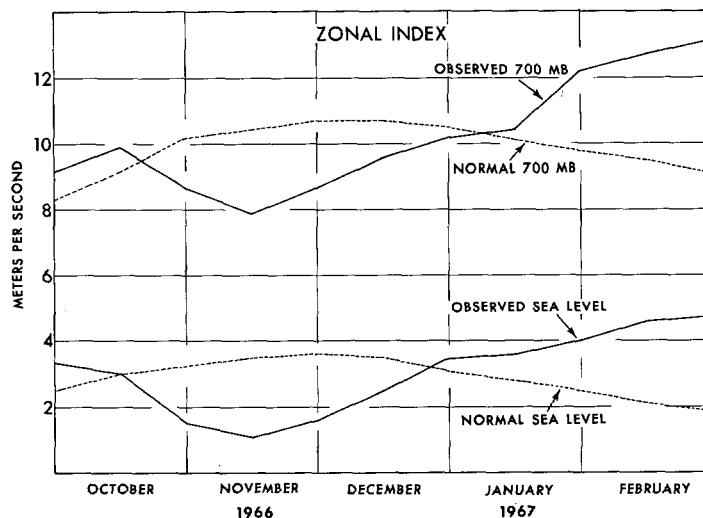


FIGURE 1.—Monthly mean zonal index (meters per second) at 700 mb. and at sea level, computed twice monthly between 35° N. and 55° N. and between 5° W. and 175° W.

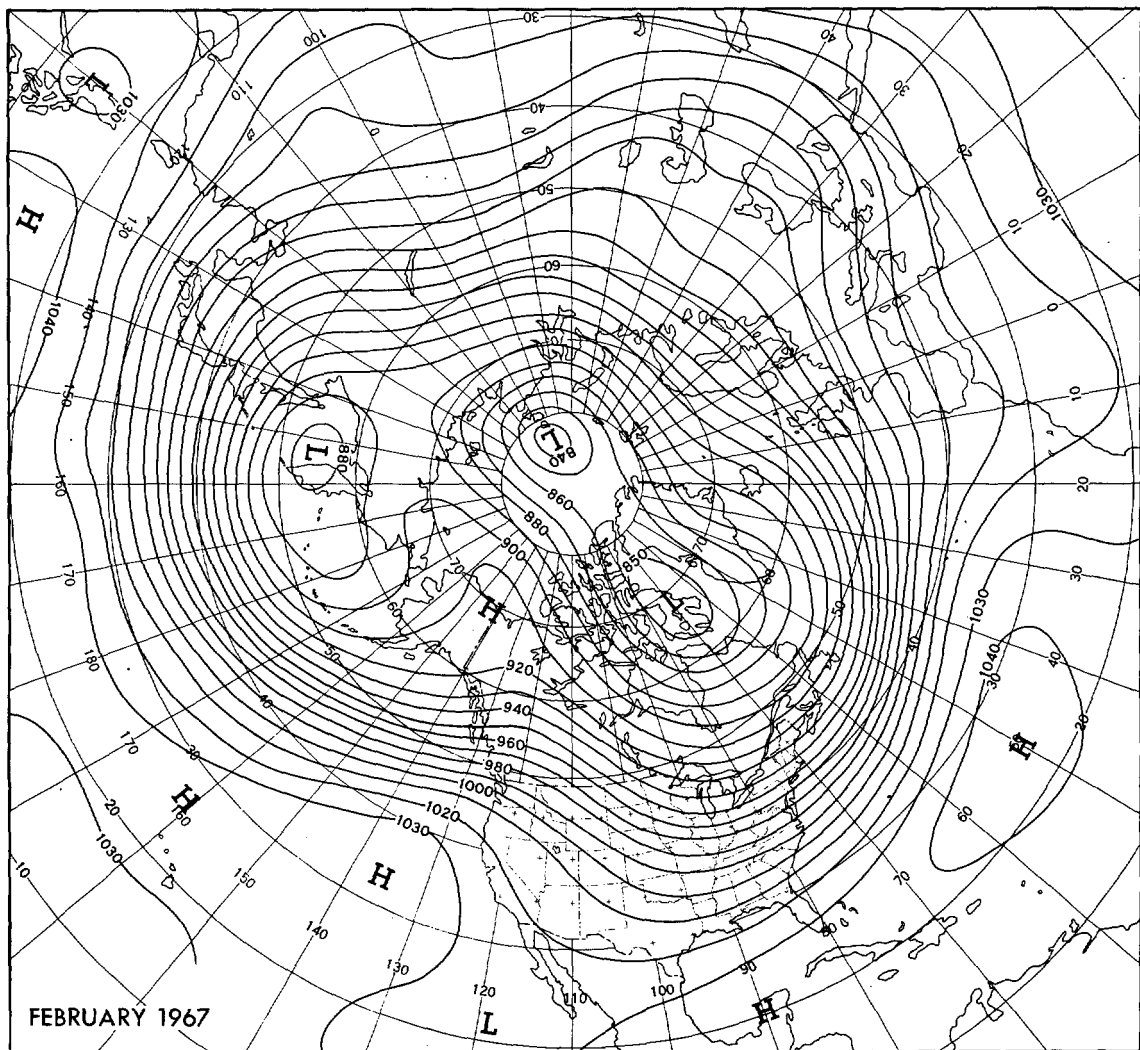


FIGURE 2.—Mean 700-mb. contours (tens of feet), February 1967.

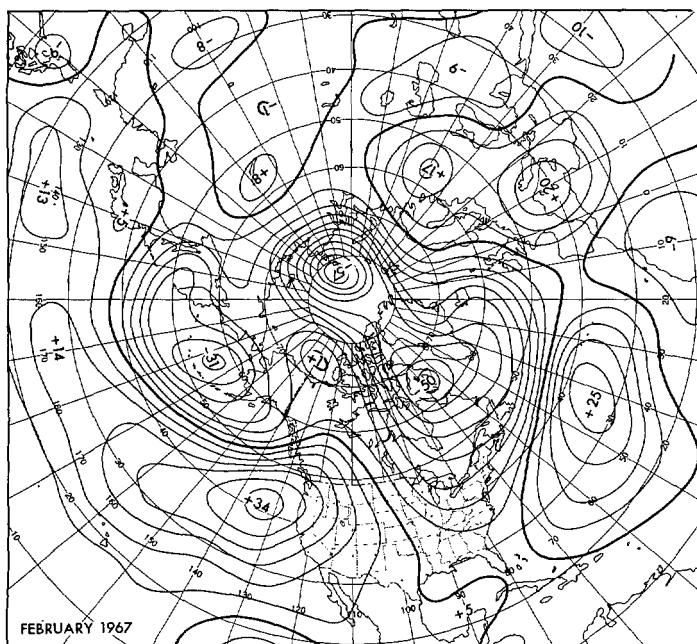


FIGURE 3.—Departure of mean 700-mb. heights from normal (tens of feet), February 1967.

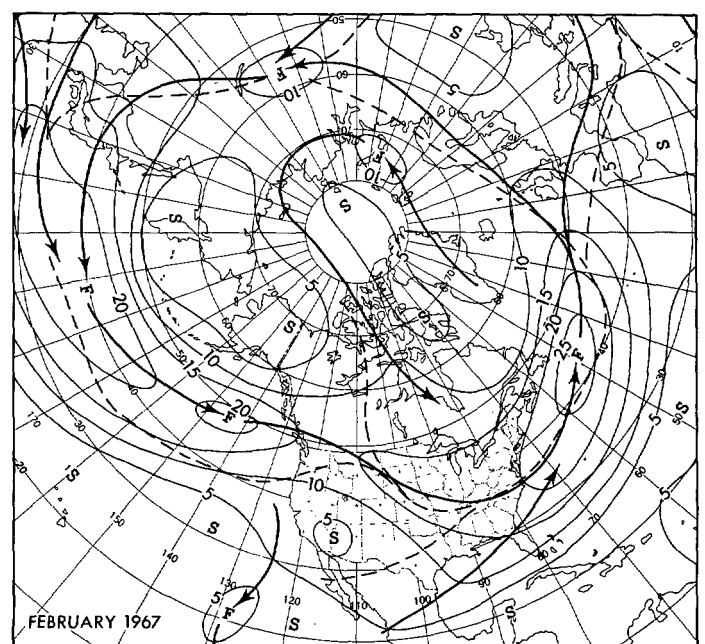


FIGURE 4.—Mean 700-mb. isotachs (meters per second), February 1967. Solid arrows indicate principal axes of maximum wind speed and dashed lines the normal axes.

TABLE 1.—Daily minimum temperature records established during February 1967

Station	Temperature (° F.)	Dates
Fort Myers, Fla.	*32	26
Lakeland, Fla.	28	26
Athens, Ga.	8, 10	25, 26
Macon, Ga.	14, 15	25, 26
Rome, Ga.	8, 9	25, 26
Peoria, Ill.	-9	25
Rockford, Ill.	-10, -11	24, 25
Evansville, Ind.	2, -3	24, 25
Lexington, Ky.	1, 0	24, 26
Baton Rouge, La.	24, 26	8, 24
Minneapolis-St. Paul, Minn.	-20, -23	24, 25
Rochester, Minn.	-13	23
St. Louis, Mo.	1	25
Newark, N.J.	9, 4	12, 13
Charlotte, N.C.	7, 7	25, 26
Raleigh, N.C.	8, 11	25, 26
Wilmington, N.C.	18, 19	25, 26
Greenville-Spartanburg, S.C.	15, 8, 18	24, 25, 26
Columbia, S.C.	13, 9, 19	25, 26, 27
Memphis, Tenn.	14	25
Nashville, Tenn.	10, 5, 8	24, 25, 26
Lynchburg, Va.	6, 10	25, 26
Richmond, Va.	12	26
Huntington, W. Va.	3, -1, 2	24, 25, 26
Milwaukee, Wis.	-8	25

\*Equaled record.

The resulting below normal 700-mb. heights and the northerly winds caused monthly mean temperatures in the East to average well below normal except for the extreme southern tip of Florida. In large areas of the East, where mean temperatures were 2°–4° F. above normal in January [1], temperatures were more than 6° F. below normal in February. Although no monthly mean low temperature records were reported in February, an extremely cold outbreak of Arctic air during the last week of the month set daily minimum records at many stations from Minnesota to New Jersey and southward to Florida and Louisiana (table 1). Very early in February a few daily maximum temperature records were established in the East before the mild January regime gave way to the colder February regime in this area (table 2).

Monthly mean temperatures continued above normal in most of the western half of the United States under the anomalously strong ridge over the West. The largest departures were more than 10° F. above normal in western Montana, with more than 4° above normal covering much of seven States. Only the Central Valley of California had mean temperatures below normal in the Far West. The unusually mild weather in the Northwest has persisted all winter [1, 2]. Walla Walla, Wash. had an average temperature of 44.1° F. for the December through

TABLE 2.—Daily maximum temperature records established during February 1967

Station	Temperature (° F.)	Dates
Kansas City, Mo.	71	13
Helena, Mont.	*61	28
Missoula, Mont.	60	28
North Platte, Nebr.	70, 69, 71	13, 14, 28
Newark, N.J.	59	2
Nashville, Tenn.	72	1
Richmond, Va.	72	2
Elkins, W. Va.	60	1
Lander, Wyo.	50	4
Sheridan, Wyo.	65	28

\*Equaled record.

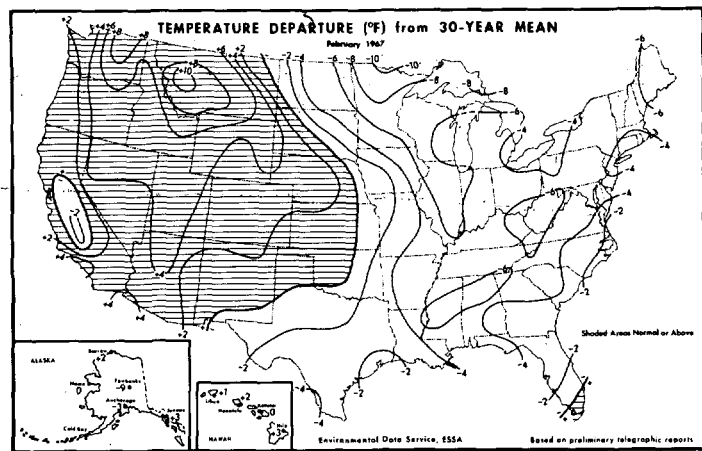


FIGURE 5.—Surface temperature departures from normal (°F.), February 1967 (from [3]).

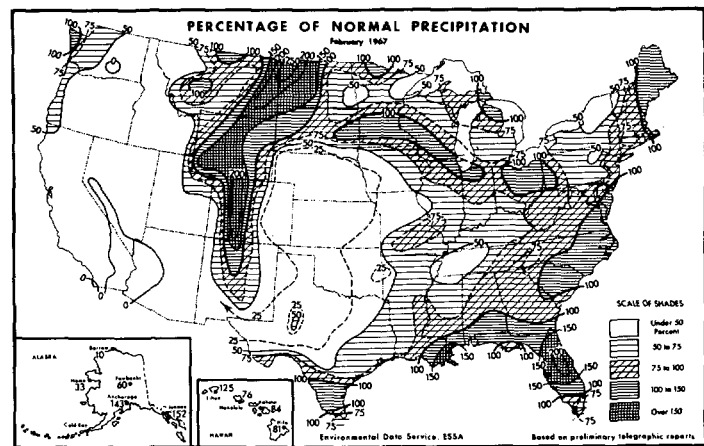


FIGURE 6.—Percentage of normal precipitation, February 1967 (from [3]).

February period, the warmest winter since 1873 for that area. Several daily maximum temperature records were set in the West during February (table 2).

### 3. MONTHLY PRECIPITATION

As would be expected from the implied subsidence of the anomalously strong anticyclonic flow (figs. 2 and 3), most of the West was quite dry this February (fig. 6). This was the first February in 79 years at Flagstaff, Ariz., and the second February in 113 years at San Diego, Calif., in which no measurable precipitation fell. Also, at Red Bluff, Calif., for the first time since records began in 1886, no measurable precipitation fell in the first 23 days of February. At the Pendleton, Oreg., airport 0.15 in. was the second lowest February precipitation since 1934, and according to cooperative observer records in the Pendleton area dating back to 1890, only 1903 had a drier February. Precipitation amounts of only 0.01 in. at Dodge City, Kans., 0.06 in. at Norfolk,

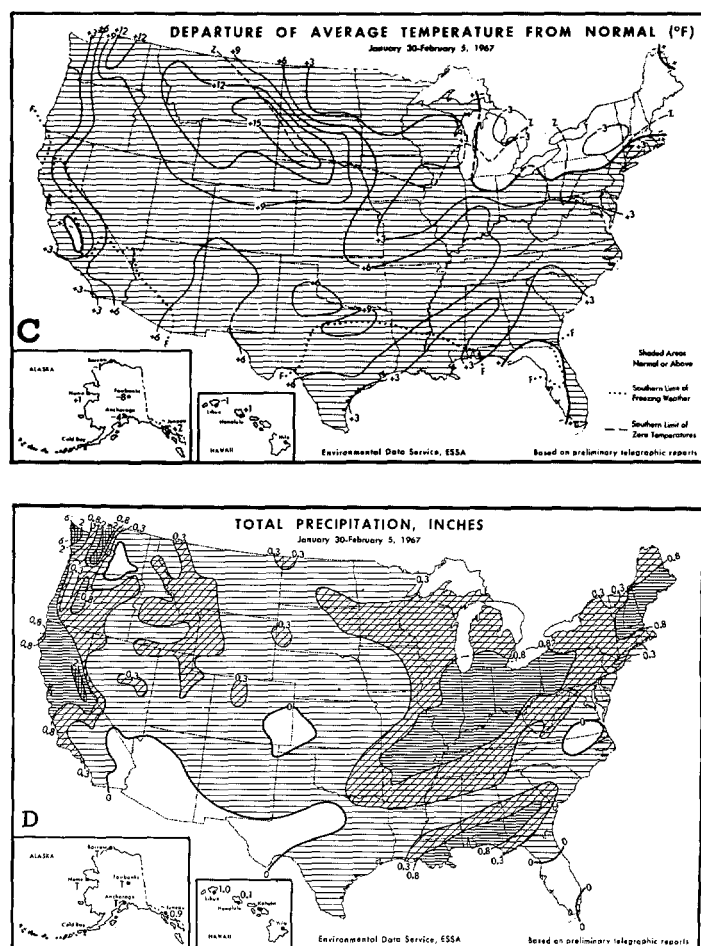
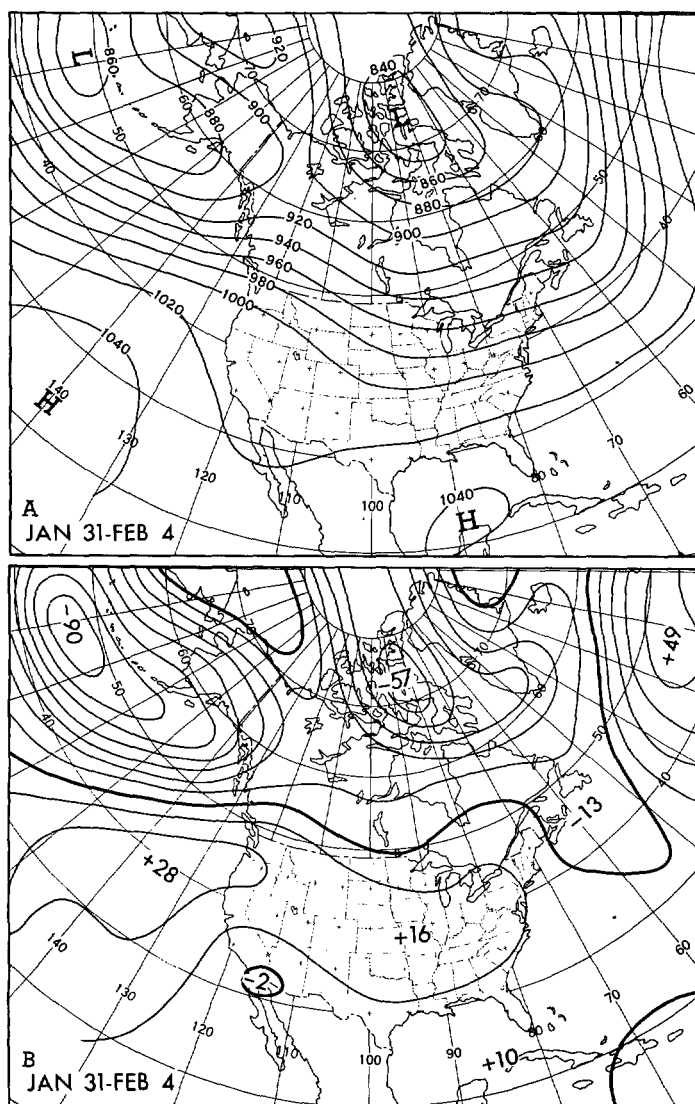


FIGURE 7.—(A) Mean 700-mb. contours and (B) 700-mb. height departures from normal (both in tens of feet) for January 31-February 4, 1967; (C) departure of average surface temperature from normal ( $^{\circ}\text{F}.$ ), and (D) total precipitation (in.) for week of January 30-February 5, 1967 (from [3]).

Nebr., and 0.18 in. at Pocatello, Idaho gave the respective stations, each with very long records, their second driest February of record.

In many areas of the West, February dryness continued extended drought. Table 3 lists some of the stations that have experienced unusual dryness for several months. Amarillo, Tex., with only 0.71 in. since September, observed the driest October-through-February period of record; and, San Antonio, Tex. with only 1.10 in. since October, had the driest November-through-February of record.

The coastal area of the Northwest had fairly large, but seasonal, amounts of precipitation as a consequence of the westerly flow against the Coastal Range. Relatively heavy precipitation was also observed in the West from the western Dakotas and eastern Montana through Wyoming into western Colorado. This precipitation was caused by migratory storms that intensified on the lee side of the Rockies, then moved eastward.

Most of the Country east of the Mississippi River had near or above normal precipitation during February. In the Ohio Valley and in much of the Northeast the precipitation was mostly in the form of snow from storms that accompanied the outbreaks of unusually cold air into the East. South Bend, Ind., had a total monthly snowfall of 31.3 in., while Friendship Airport at Baltimore, Md., reported a record February snowfall of 20.1 in. A total monthly snowfall of 32.6 in. at Concord, N.H. was the largest February amount there since 1920. Not

TABLE 3.—Length of dry period at several western stations

Station	Consecutive Months with Below Normal Precipitation	Station	Consecutive Months with Below Normal Precipitation
Phoenix, Ariz.....	5.	Pocatello, Idaho.....	14 (excepting 1 month).
Winslow, Ariz.....	3.	Amarillo, Tex.....	5.
Denver, Colo.....	5.	San Antonio, Tex.....	6.

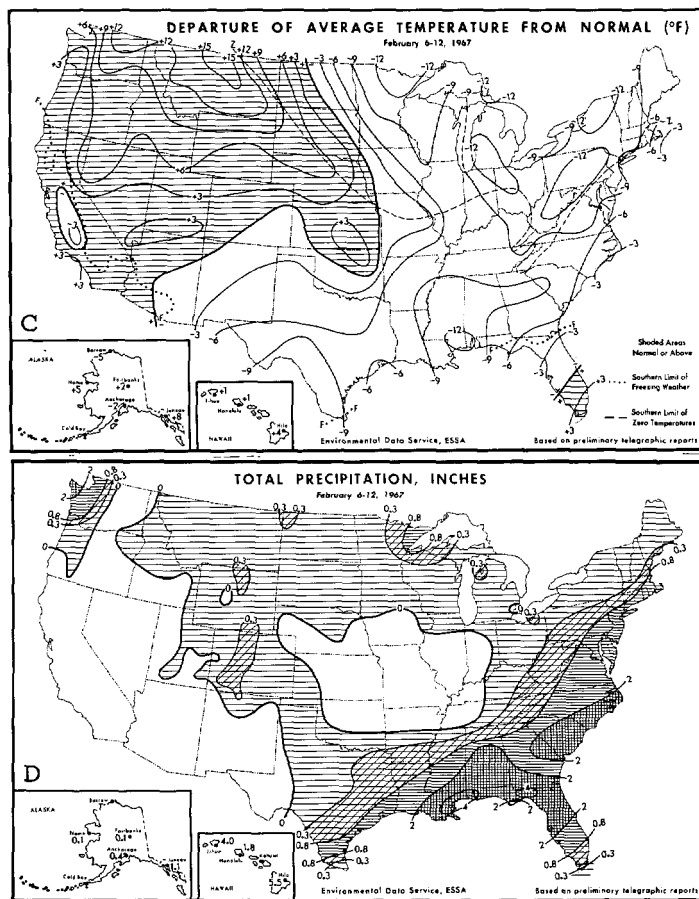
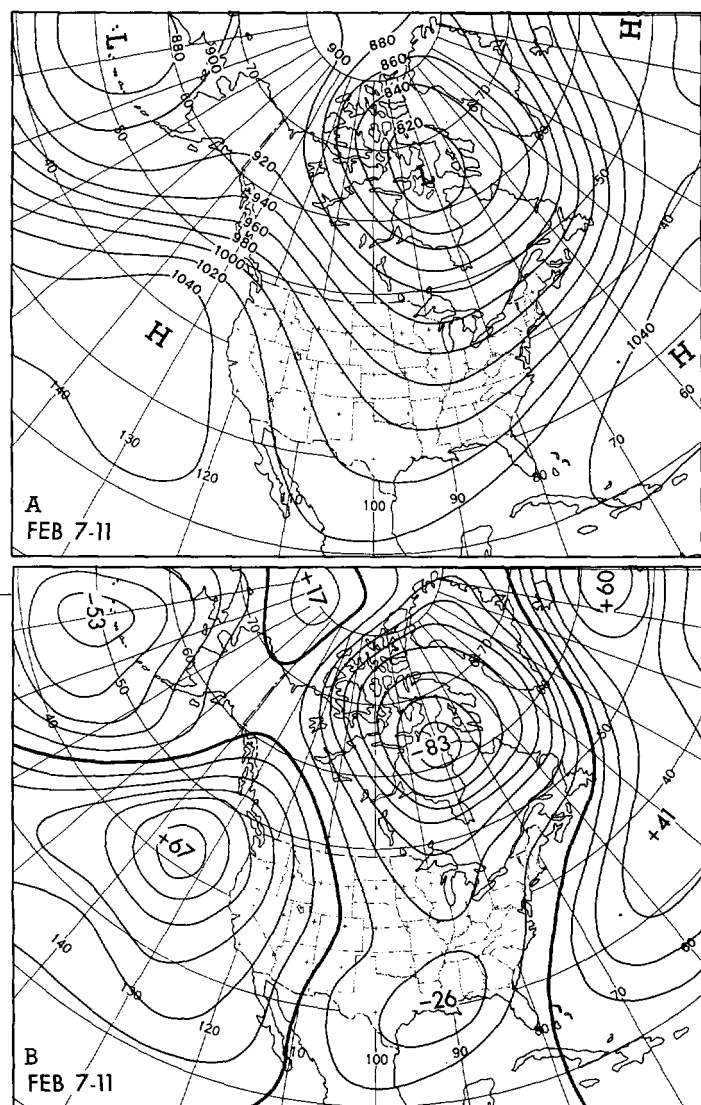


FIGURE 8.—Same as figure 7, (A) and (B) for February 7-11, 1967; (C) and (D) for February 6-12, 1967 (from [3]).

only were the amounts of snowfall unusually large, but also the frequency was high. Beckley, W. Va., reported a trace or more of snowfall on 22 days. Many stations in the Ohio Valley reported near record amounts of snowfall for February. The heavy rain in the Gulf Coast States (fig. 6) as well as the heavy snowfalls farther north in the East were associated with the deepening eastern trough.

#### 4. VARIATIONS OF THE WEATHER AND CIRCULATION WITHIN THE MONTH

During the first several days of February, the January regime persisted with zonal flow over most of North America (fig. 7A) and above normal 700-mb. heights over the United States (fig. 7B). Average temperatures for the first five days of February and the last two days of January were mostly above normal as a result of the strong zonal flow and above normal 700-mb. heights

(fig. 7C). It was in this period that daily maximum temperature records were set at several stations (table 2). By the 5th of February however, the first really cold air mass was spreading southward bringing sub-zero temperatures to the Dakotas and Minnesota.

Most of the precipitation in the East this week (fig. 7D) occurred with a relatively weak storm that moved out of Texas on the first day of the month in conjunction with the shallow mean trough extending from the Great Lakes to the Southern Plains (fig. 7A). Westerly flow against the higher terrain and the minor mean trough over the Southwest caused the heavier precipitation in the Far West.

A shallow mean trough over the Great Lakes and lower Mississippi Valley early in the month deepened sharply during the second week, effecting a major retrogression of the long-wave trough from just off the east coast to a position from James Bay to Mexico (fig. 8A). This retrogression and resulting negative height anomaly over the

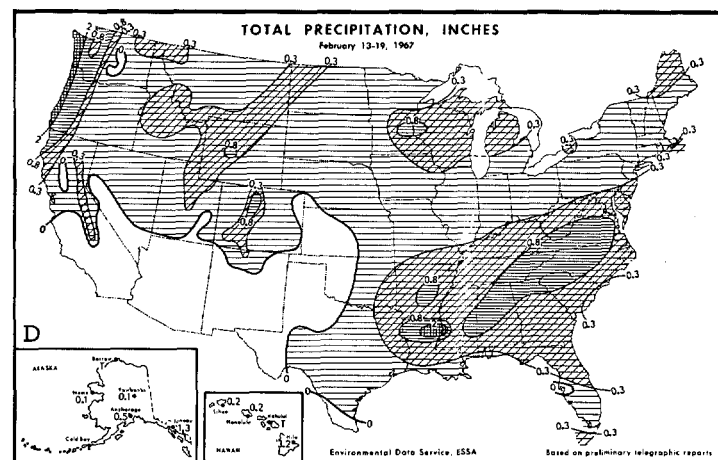
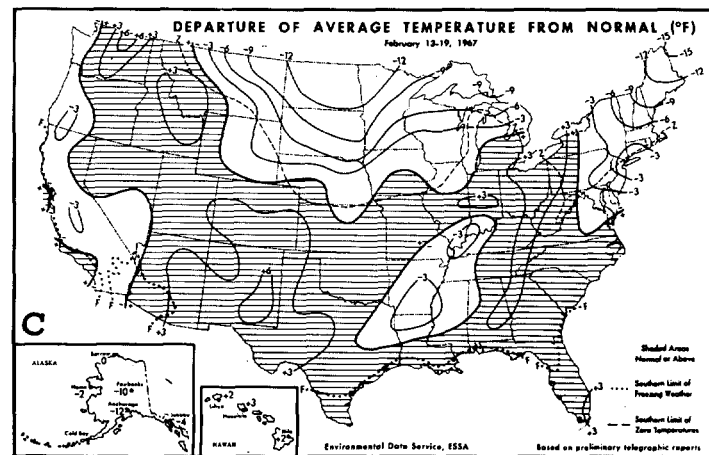
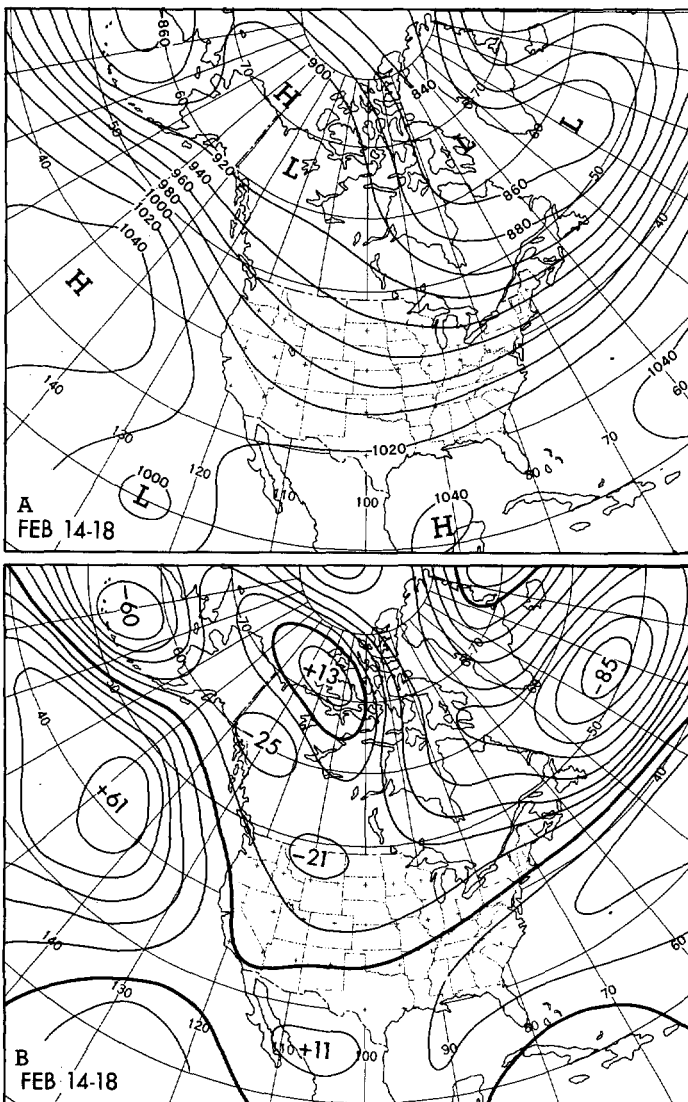


FIGURE 9.—Same as figure 7, (A) and (B) for February 14-18, 1967; (C) and (D) for February 13-19, 1967 (from [3]).

eastern two-thirds of the United States (fig. 8B) was accompanied by very cold air over the East and the Southern Plains (fig. 8C). Warm air persisted in the Northern Plains to the central Dakotas and southward to Kansas as a result of foehn warming, even though 700-mb. heights were below normal east of central Montana and the anomalous flow was quite northerly. The strongly anomalous ridge over the Far West guaranteed warm air in that area except for the central part of the California Valley, where generally clear skies and relatively long nights encouraged radiational cooling and cool air drainage.

Large areas of the Far West had no precipitation in the second week of February (fig. 8D) because of the subsidence in the strong ridge over the area. The Central Plains and central Mississippi Valley also recorded no precipitation this week. This dry area was just to the west of the mean trough and also happened to be between the two storm tracks of the week. Two developing storms

moved out of the southern part of the mean trough in the East giving very heavy precipitation to the Southeast and moderate amounts farther north near the coast. A third storm moved along the northern border of the Country causing the more northern precipitation.

Retrogression continued in the upper-level flow over the United States during the third week of the month (fig. 9A), as the western ridge moved to the Gulf of Alaska, and the southern part of the major mean trough moved to the Far Southwest. This retrogression of the lower-latitude wave train, while the ridge in the more northern westerlies north of Alaska progressed slightly, cooled the Northern Plains and continued the cold regime in the Northeast (fig. 9C). The Southern Plains and most of the East warmed under southwesterly anomalous flow (fig. 9B) and near or above normal 700-mb. heights. In the absence of an amplified flow that would bring either cold continental Polar air across the Rockies or cold short-trajectory maritime air from the Pacific, the residual



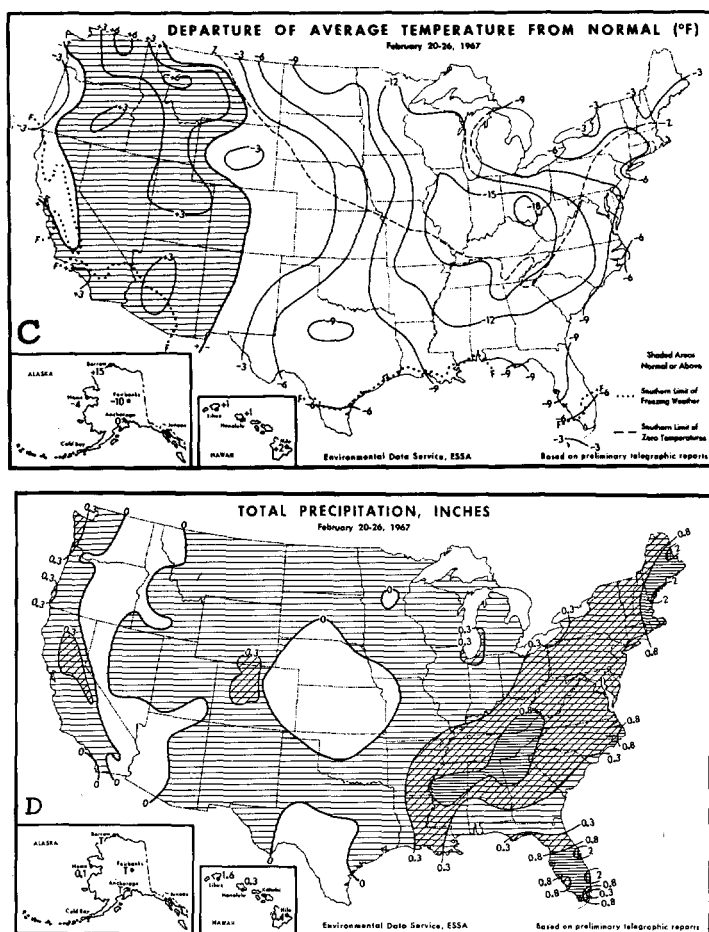
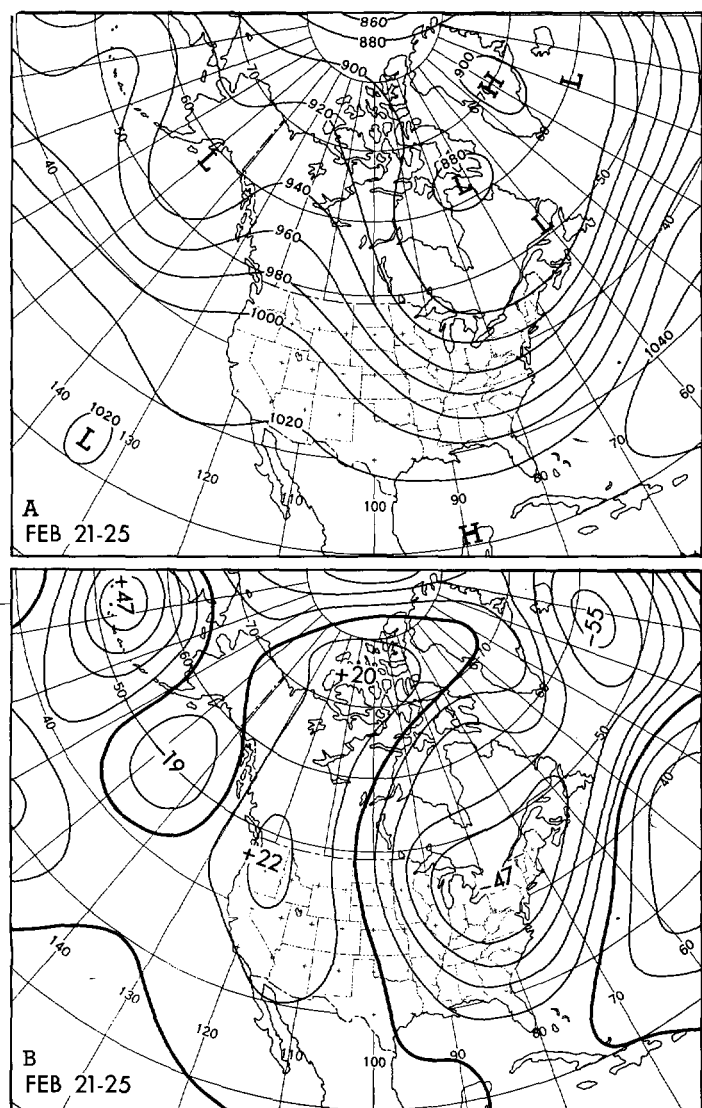


FIGURE 10.—Same as figure 7, (A) and (B) for February 21-25, 1967; (C) and (D) for February 20-26, 1967 (from [3]).

mild Pacific air kept temperatures above normal over the Great Basin and in all except the coastal sections of the Northwest. The retrograding trough, however, did bring below normal temperatures to the immediate coast of the Northwest and the majority of California.

A rather typical Colorado storm moved rapidly eastward through the southern Great Lakes region and across New England as it intensified on the 15th and 16th. This storm gave heavy snowfall to some areas and extremely strong and damaging winds. In Ohio, winds ranging from 30 to 81 m.p.h. and continuing for 7 hours left a trail of shattered windows, mangled trees and utility poles, dented automobiles, roofless homes, and fallen wires. In New England winds also reached hurricane force, damaging trees, buildings, construction equipment, and utility lines. Most of the precipitation in the East (fig. 9D) occurred with this storm and a weak cyclonic disturbance that moved across Florida into the Atlantic on the 13th.

Precipitation in the West came mainly from a storm late in the week that moved from the Gulf of Alaska south-eastward to the southern Rockies as retrogression continued.

Late in February progression occurred with the southern wave train ridge returning to the west and amalgamating with the ridge in the more northern band of westerlies (fig. 10A). The amplification and strong northerly anomalous flow that resulted (fig. 10B) spread Arctic air over most of the eastern two-thirds of the United States (fig. 10C). Many daily low temperature records were set (table 1) between the 23d and 27th. Under the upper-level ridge most of the West continued warmer than normal, but the immediate coastal area of Oregon, coastal northern California, and parts of interior northern California had slightly below normal temperatures the final week of February.

The return of the strong ridge to the West brought relative dryness to most sections west of the Mississippi River, but east of the Mississippi the storminess that preceded the outbreak of very cold air gave widespread but generally moderate amounts of precipitation. Some

of this storminess reached blizzard proportions in many northern States, while cold fronts caused heavy thunderstorms from eastern Texas to the central Appalachians. Westerly winds exceeded 50 m.p.h. in portions of the North Central States during midweek and over the Northeast during the weekend. Winds reached 82 m.p.h. at Ogden Dunes, Ind., as the storm moved through the Great Lakes region. Up to 18 in. of snow fell at some locations in northern New England this week.

## REFERENCES

1. W. R. Winkler, "The Weather and Circulation of January 1967—A Mild Month With Unusually High Zonal Index," *Monthly Weather Review*, vol. 96, No. 4, Apr. 1967, pp. 227-233.
2. R. R. Dickson, "The Weather and Circulation of December 1966—Blocking Over North America," *Monthly Weather Review*, vol. 96, No. 3, Mar. 1967, pp. 148-152.
3. Environmental Data Service, ESSA, *Weekly Weather and Crop Bulletin, National Summary*, vol. 54, Nos. 6-10, Feb. 6, 13, 20, 27, and March 6, 1967.